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UNIVERSITY OF OREGON BULLETIN

NEW SERIES MAY, 1910 Vol. VII, No. 9

# THE

# COLLEGE OF ENGINEERING

## Announcements, 1910-1911

Published monthly by the University of Oregon, and entered at the postoffice
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THE

# College of Engineering

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## Announcement of Courses

1910-1911

THE University of Oregon Bulletin is published monthly during the University year, and will be sent free on application. Requests for Bulletins, or for general information in regard to the University, should be addressed to

THE REGISTRAR,
University of Oregon, Eugene, Oregon.

# CALENDAR—1910

**July.**

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## 1911

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**July.**

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**Dec.**

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## CALENDAR

September 19.—Admission examinations.
September 20 to February 10.—First semester.
February 13 to June 21.—Second semester.

### CALENDAR IN DETAIL

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| September 19, Monday. | Entrance examinations at Eugene for the College of Literature, Science and the Arts, and the College of Engineering. Examinations for removal of conditions. |
| September 20, Tuesday.<br>Sept. 21, Wednesday. | First semester opens. Payment of incidental fees and registration. Filing of applications for undergraduate, graduate and special student standing, if such applications have not already been filed. Instructors keep office hours for consultation with the students. |
| September 22, Thursday. | All University work begins. |
| September 30, Friday. | Reception to the new students by the Christian Associations. |
| October 7, Friday. | Last date for filing subjects for senior theses with the Registrar. |
| November 23, 12 m. to<br>November 27, Sunday. | Thanksgiving recess. |
| December 5, Monday.<br>December 6, Tuesday. | Examinations for removal of conditions. |
| December 17, Saturday,<br>to January 2, Monday. | Christmas vacation. |
| January 3, Tuesday. | Recitations begin 8 a. m., after Christmas holidays. |
| February 1. Wednesday. | Mid-year examinations begin. |
| February 10, Friday. | First semester ends. |
| February 13, Monday. | Second semester begins. |
| February 22, Wednesday. | Regular meeting of Associated Students. |
| April 15, Saturday.<br>April 23, Sunday. | Spring vacation. |
| May 1, Monday.<br>May 2, Tuesday. | Examinations for removal of conditions. |

| | |
|---|---|
| May 1, Monday. | Last date for filing applications for graduate degrees with the Registrar. |
| May 12, Friday.<br>May 13, Saturday. | Junior Week-End. Holidays. |
| May 22, Monday. | Last date for filing graduate theses with the Registrar. |
| May 30, Tuesday. | Memorial Day. A holiday. |
| June 3, Saturday. | Last date for filing senior theses with the Registrar. |
| June 7, Wednesday. | Final examinations begin. |

## COMMENCEMENT WEEK

| | |
|---|---|
| June 18, Sunday. | Baccalaureate sermon, 11 a. m. |
| June 19, Monday. | Field day, 2 p. m.; recital School of Music, 8 p. m. |
| June 20, Tuesday. | Alumni business meeting, 10 a. m.; President's reception, 3 p. m.; Failing-Beekman contest, 8 p. m. |
| June 20, Tuesday. | Regular meeting of the Board of Regents, President's office, Villard Hall. |
| June 21, Wednesday. | Commencement exercises, 10 a. m.; Alumni banquet, 1 p. m.; Alumni ball, 9 p. m. |

# COLLEGE OF ENGINEERING

## THE FACULTY

P. L. Campbell, B. A., President.

Edward Hiram McAlister, M. A., Dean of the College of Engineering, and Professor of Civil Engineering.

Percy Paget Adams, B. S., Assistant Professor of Civil Engineering.

Franklin L. Barker, E. M., Professor of Geology.

James D. Barnett, Ph. D., Professor of Political Science.

John Freeman Bovard, M. S., Professor of Zoology.

William Pingry Boynton, Ph. D., Professor of Physics.

Robert Carlton Clark, Ph. D., Professor of History.

Timothy Cloran, Ph. D., Professor of Romance Languages.

Richard Harold Dearborn, M. E., Professor of Electrical Engineering.

Edgar Ezekiel DeCou, M. S., Professor of Mathematics.

Fred Goodrich Frink, M. S., Professor of Railway Engineering.

James Henry Gilbert, Ph. D., Assistant Professor of Economics.

Irving Mackay Glen, M. A., Professor of English Language and Early English Literature.

William L. Hayward, Director of Men's Gymnasium.

Herbert Crombie Howe, B. A., Professor of Modern English Literature.

Heman Burr Leonard, Ph. D., Assistant Professor of Mathematics.

Joseph Schafer, Ph. D., Professor of History.

Friedrich Georg G. Schmidt, Ph. D., Professor of German.

Frederick LaFayette Shinn, Ph. D., Assistant Professor of Chemistry.

Orin Fletcher Stafford, B. A., Professor of Chemistry.

Albert Raddin Sweetser, M. A., Professor of Botany.

Edward Allen Thurber, M. A., Professor of Rhetoric.

Frederick George Young, B. A., Professor of Economics.

Julia Burgess, M. A., Instructor in English.

Charles W. Converse, M. A., Instructor in Electrical Engineering.

Hugo W. Koehler, B. A., Instructor in German.

Ellen M. Pennell, Instructor in English.

Mary A. Perkins, M. A., Instructor in English.

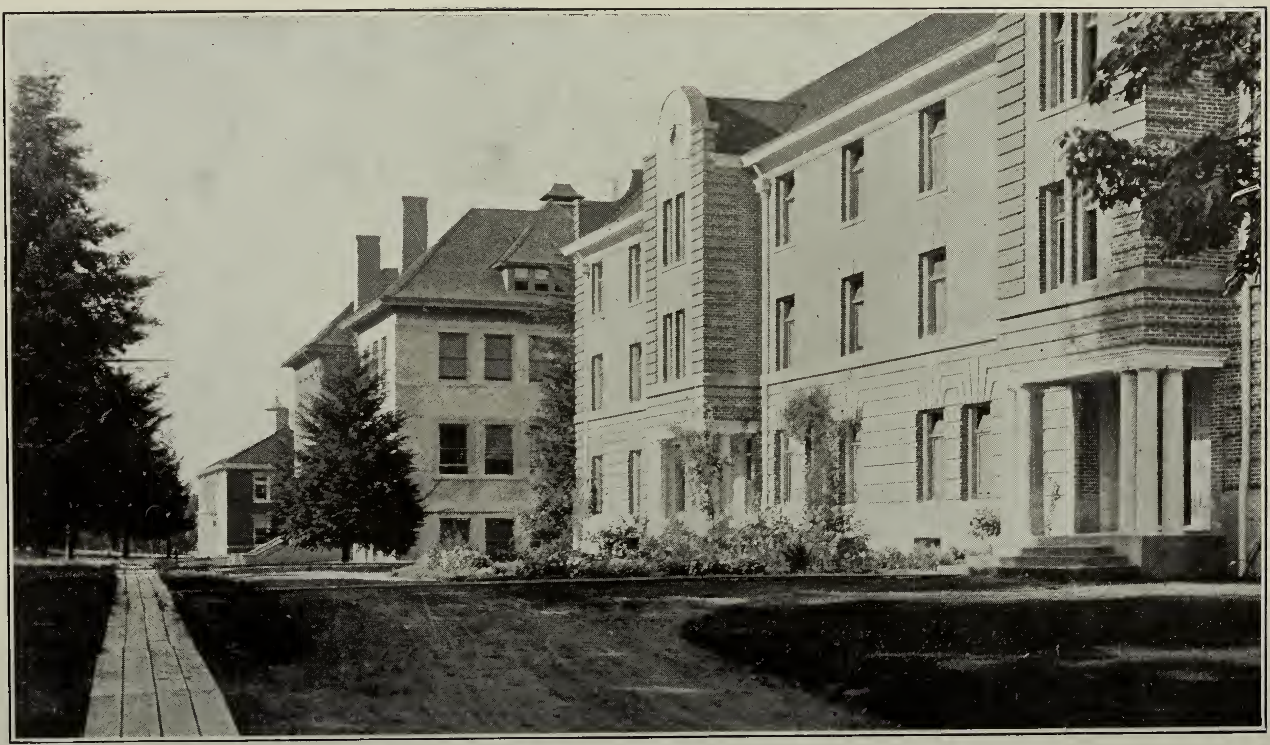
Carl A. McClain, B. S., Instructor in Civil Engineering.

Charles Roy Reid, B. S., Instructor in Electrical Engineering.

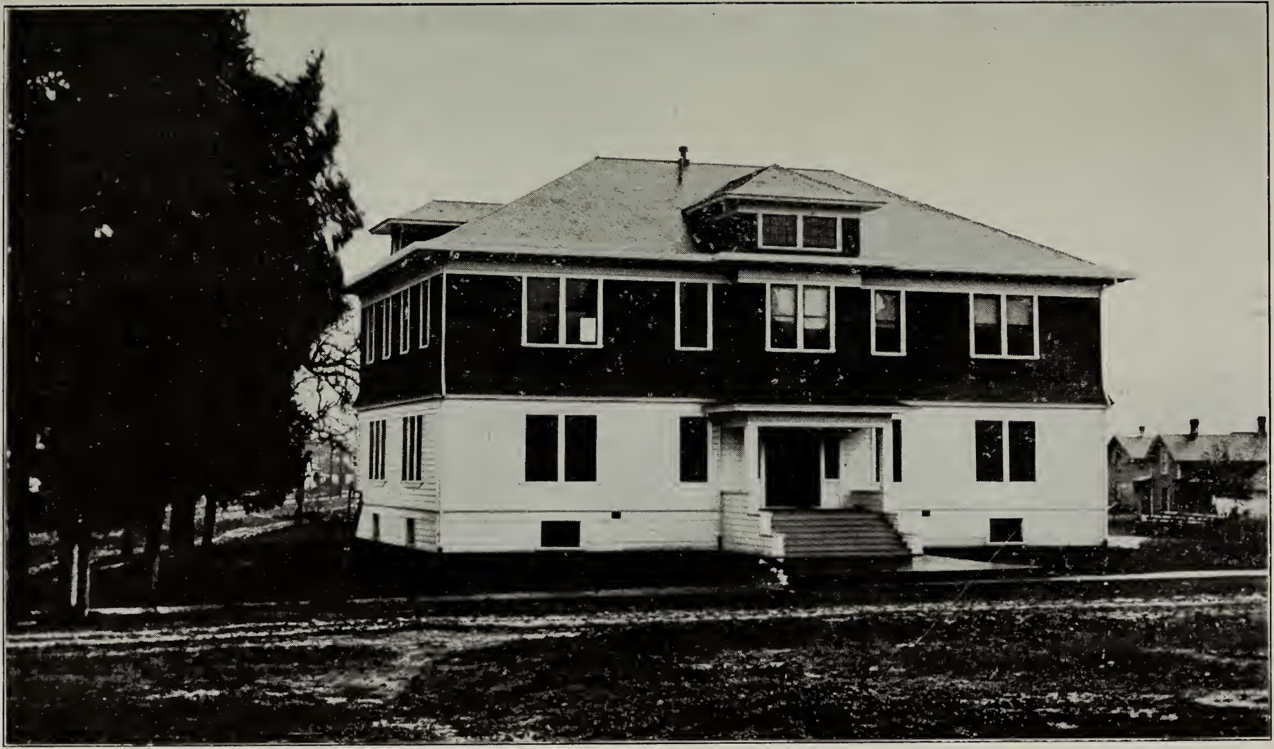
Paul G. Bond, B. A., Assistant in Physics.

Frank H. Swift, Assistant in Machine Shop.

Edwin Platts, Assistant in Wood Shop.

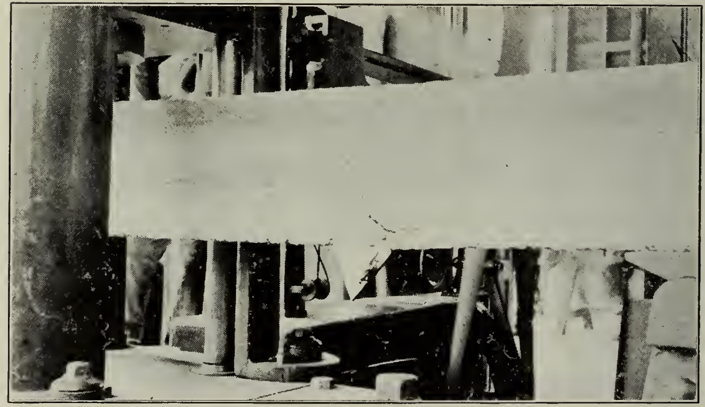


ELECTRICAL BUILDING, McCLURE HALL, AND MEN'S DORMITORY

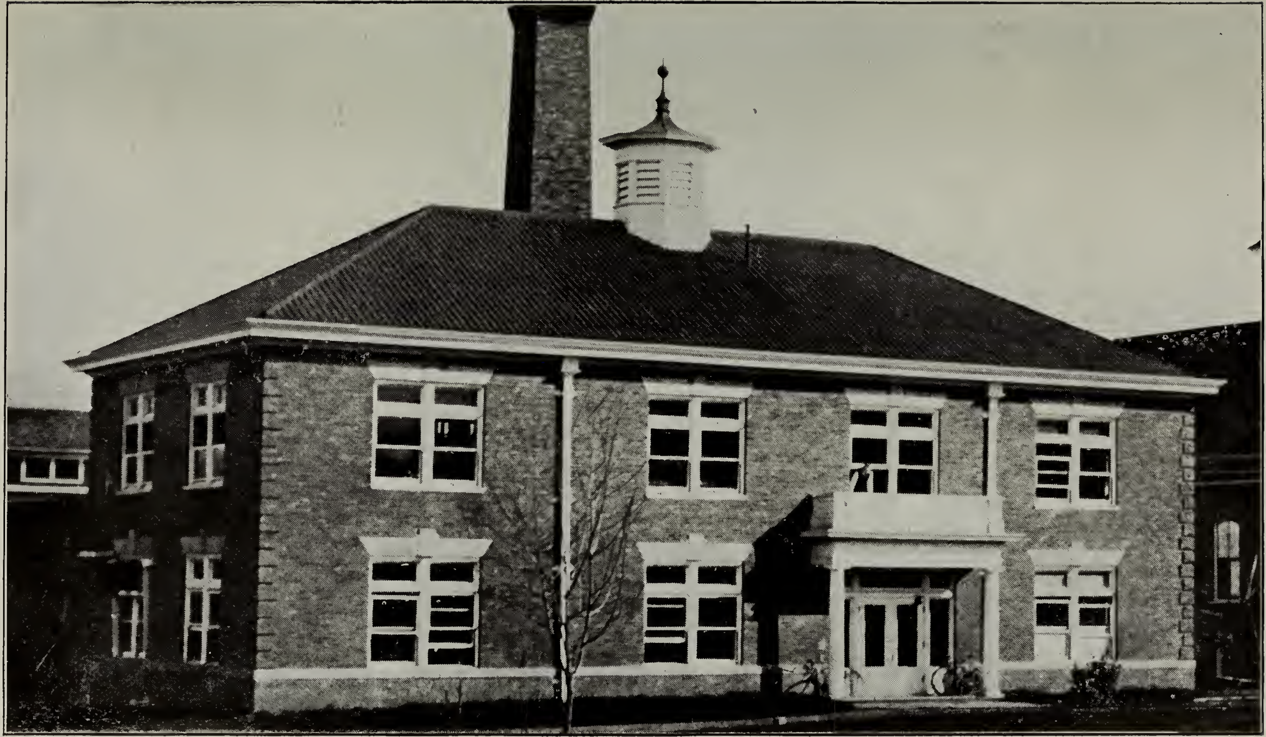


CIVIL ENGINEERING BUILDING

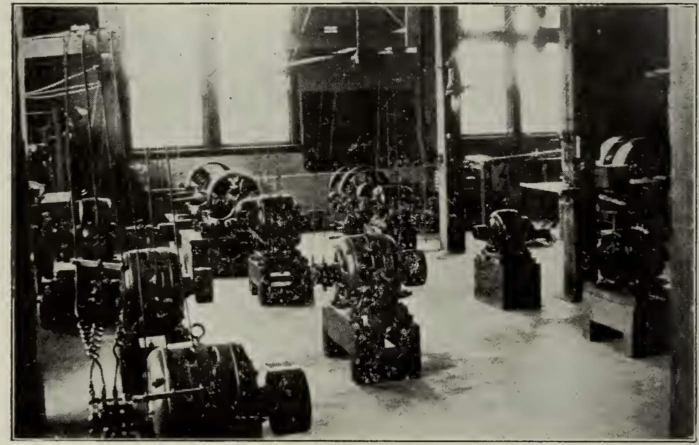
MEASUREMENT OF STREAM FLOW



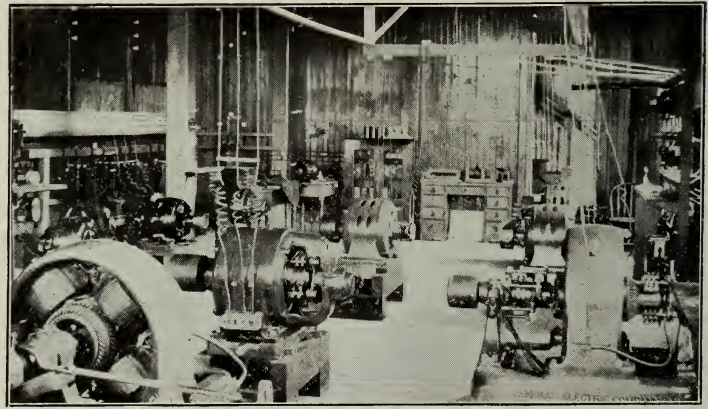
TEST OF CONCRETE BEAM, SHOWING FRACTURE



ELECTRICAL BUILDING

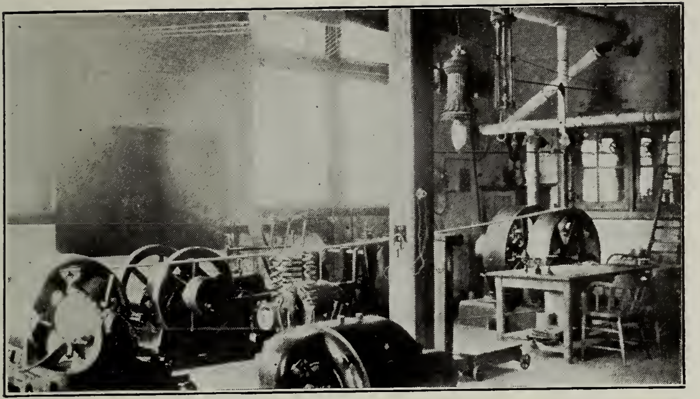


ALTERNATING CURRENT

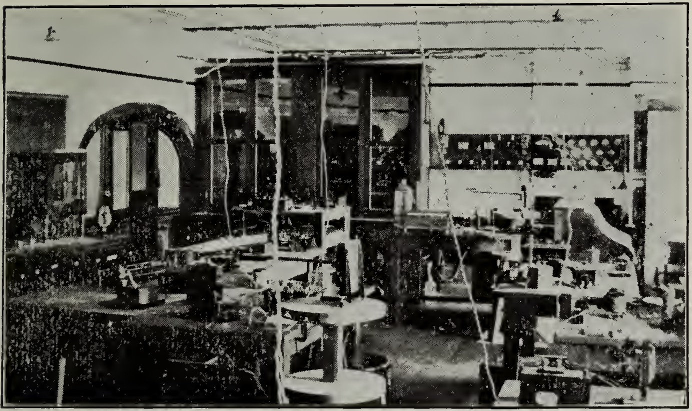


DIRECT CURRENT

ELECTRICAL LABORATORIES



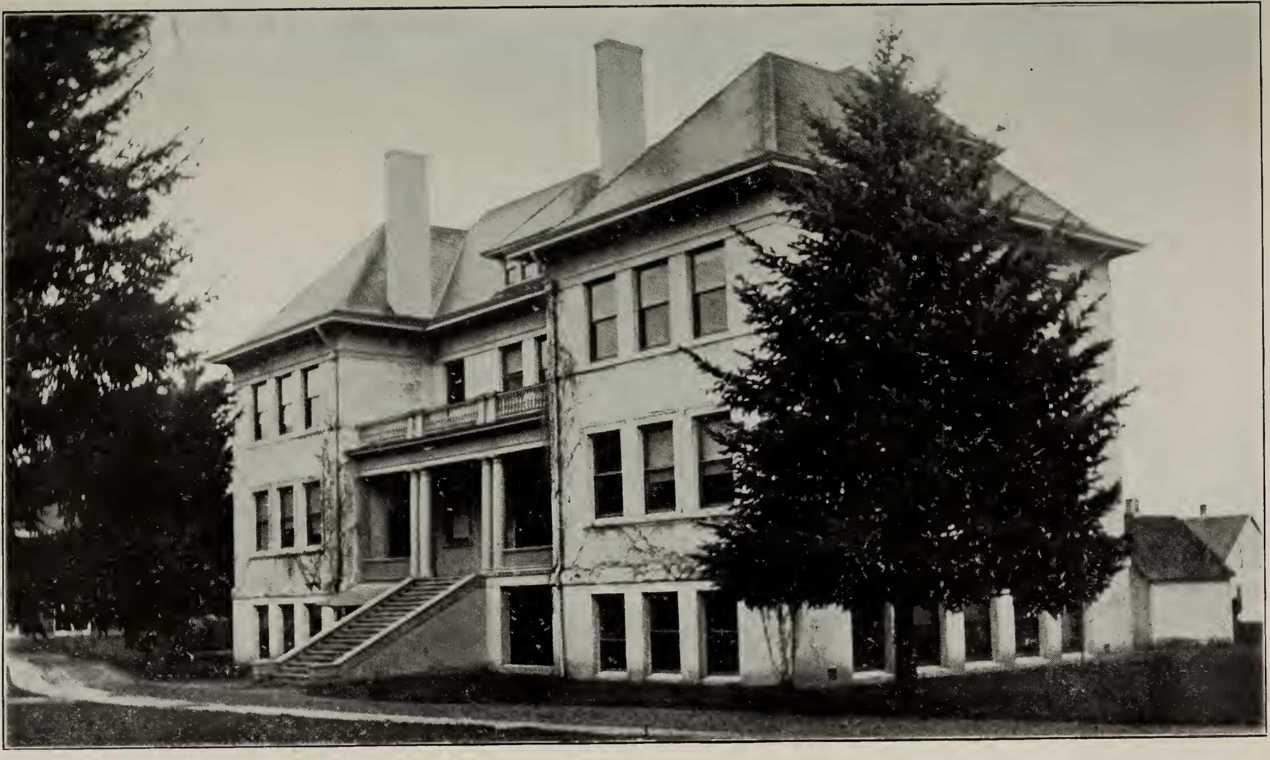
STEAM AND GAS ENGINE LABORATORY



ELECTRICAL STANDARDS LABORATORY

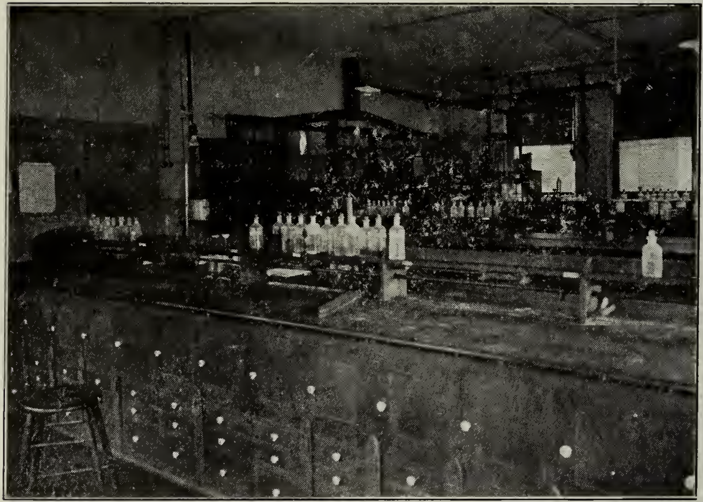
ENGINEERS ON INSPECTION TRIP

FRESHMAN DRAFTING ROOM



McCLURE HALL. CHEMICAL ENGINEERING

CHEMICAL ENGINEERING LECTURE ROOM



FRESHMAN CHEMICAL LABORATORY

# THE COLLEGE OF ENGINEERING

## PURPOSE.

The purpose of the College of Engineering is to ground students thoroughly in the fundamental sciences and arts upon which all engineering rests, and to give such special and technical knowledge of the various branches of engineering as is practicable in the time available.

In conformity with the present tendency in other engineering colleges of high rank, it is expected that in the near future the engineering courses of the University of Oregon will be extended to cover a period of five years above the four years of high school preparation.

The lengthened courses will aim to give the student an increased amount of technical work, and will include also courses in economics, sociology, cost-keeping, management and operation of works, and such other courses as may seem essential to the attainment of the highest success in an engineering career.

The longer time required for graduation will serve also to bring about another very desirable result, namely, the greater maturity of the student at the time when he is taking his specialized work in engineering, enabling him better to grasp the meaning of the larger engineering problems.

The professional engineer of today, the man trained for the responsible positions in large companies, should have a broad, liberal education in addition to the technical knowledge in his own special field. These added courses, intended to give this broadening, mean more time and preparation, and while the College of Engineering will continue to offer four-year courses in Civil, Electrical, Chemical and Railway Engineering, it will strongly recommend the extra year to all students taking engineering work.

The Pacific Northwest has almost unlimited possibilities for engineering development. No part of the country has greater opportunities for the development of water power and the production of raw materials. Large portions of the Northwest, hitherto untouched by railways, are now being opened up. The engineers best fitted to solve the problems involved are those who have been trained on the ground and who are familiar with the local conditions.

## ADMISSION.

For full entrance to the freshman class of the College of Engineering, fifteen units are necessary, of which ten are in required and five in elective subjects. Graduates of high schools who for any reason do not have fifteen units may enter as conditioned freshmen if they have satisfactorily completed at least thirteen units. All conditions must be made up during the first and second years of residence at the University.

By a unit is meant a subject running one year (36 weeks) five times a week, with recitations not less than forty minutes in length.

The subjects required of all freshmen entering the College of Engineering are as follows:

| | |
|---|---|
| English | 3 units |
| Algebra | 1½ units |
| Plane and Solid Geometry | 1½ units |
| One Foreign Language | 2 units |
| History | 1 unit |
| Physics | 1 unit |
| Elective | 5 units |
| Total | 15 units |

## GRADUATION.

The degree of Bachelor of Science is conferred upon students of the College of Engineering who have secured 120 semester hours of credit, exclusive of eight semester hours of required physical training, and including the work required by their major professor.

## DEGREE OF ENGINEERING.

The professional degree of Engineer is conferred upon graduates of the University, or of other institutions of like rank, who complete a year of professional study beyond the baccalaureate requirements of the department in which the degree is sought, and who present an approved thesis showing ability to do independent work.

## INCIDENTAL FEE.

There is no tuition at the University of Oregon. The incidental fee, payable each year by students in all departments of the University, is $10. There is also a student-body tax of $5 per year for the support of student enterprises. Graduate students are not required to pay the student-body tax.

A diploma fee of $10 is charged for the first degree taken, and $10 for each succeeding degree. The rules prescribe that no person shall be recommended for a degree until he has paid all dues, including the diploma fee.

## GENERAL EXPENSES.

Comparative statement of student's expenses for the academic year, from September to June:

| | Low. | Average. | Liberal. |
|---|---|---|---|
| Incidental Fee | $ 10 00 | $ 10 00 | $ 10 00 |
| Student Body Tax | 5 00 | 5 00 | 5 00 |
| Board and Room | 162 00 | 192 00 | 270 00 |
| Sundries | 33 00 | 93 00 | 115 00 |
| | $ 210 00 | $ 300 00 | $ 400 00 |

The expenses of one person for a year vary according to the circumstances of the case, but, as will be seen from the above statement, are in general very low. The following estimate is probably substantially correct: Room from $0.75 to $3.00 per week; board from $3.50 to $5.00 per week; board and room in Men's Dormitory, $4.00 to $4.50 per week; board and room in Women's Dormitories, $4.00 and $4.50 per week; books from $5.00 to $20.00 per year. Students often rent rooms and do light housekeeping, thus reducing the cost of living to a very low point.

## MEN'S DORMITORY.

Board and room in the Men's Dormitory may be secured at $4.50 per week, and board without room at $3.50 per week. The dormitory contains about 50 rooms and 40 outside boarders may be accommodated. The rooms are large and comfortable and are steam heated. Each is completely furnished, with the exception of mattress, bedding, and linen. A room deposit of $10, returnable at the close of the year, is required of each applicant, and must be paid by September 1st. Applications for rooms should be addressed to the Clerk of the Men's Dormitory, University of Oregon, Eugene.

## ROOMS IN PRIVATE FAMILIES.

The University publishes about September 1st of each year a directory of approved rooming and boarding places. The directory is sent free of charge, and copies may be secured by addressing the Registrar. The number of rooming and boarding places each year is large, and students will have no trouble in finding good locations. Ordinarily, it is not advisable to engage a room before reaching Eugene. The price of rooms varies from $0.75 to $3.00 per week, and board from $3.50 to $5.00 per week.

## SELF-SUPPORT.

Seventy per cent of the men attending the University during 1908-09 and 1909-10 were either wholly or partly earning their own way by work in the summers and by work done during the college year. Eugene is a rapidly growing town of 12,000 inhabitants, whose citizens are friendly to the University and take pleasure in affording to students the opportunity to earn their necessary expenses. The work available during the session consists of janitor work, typewriting, reporting, tutoring, waiting on table, clerking, clothes pressing, odd jobs, etc. The Y. M. C. A. conducts a free labor bureau, which is at the service of the students. The demand for student help is usually larger than the supply. The University is glad to be of all possible assistance to those desiring to find work.

## LABORATORY FEES.

In all laboratory courses a charge is made for the use of the laboratory and its equipment, for supplies used, and for breakage. At the end of the semester or year, depending on the course taken, any cash balances are returned or collected as the case may be. Payment of the fee must be made before enrollment in any laboratory course.

Following are the amounts of deposit required and a statement of the usual expenses of the different courses:

### Civil Engineering.

Deposit for Testing Laboratory, Topographical Surveying, or Masonry Laboratory, $2.50.

Key deposit for Mechanical Drawing, $1.00; refunded at the end of the course on the return of the key.

### Electrical Engineering.

Deposit $3.00 for each course.

### Chemical Engineering.

The deposit for each course is $10. Additional expense for supplies, if any, is met by the purchase of coupons. All returnable material, as well as unused portions of coupons, are redeemed at the close of the laboratory work in any course at their cash value. The usual cost to the student is as follows:

General Chemistry, $10.
Analytical Chemistry, $15 to $20.
Organic Chemistry, $15 to $20.
Physical Chemistry, $10.

### Gymnasium.

Locker fee, $1.50. Of this amount $0.50 is refunded when the locker is surrendered and the keys returned.

### Physics.

A deposit of $5.00 is required for each course each semester. The usual expense for Courses 1 and 3 is $2.50 per semester.

## ENGINEERING CLUB.

*The Engineering Club* was organized November 30, 1904. Engineering students in Sophomore, Junior and Senior classes are eligible for membership. The club holds its meetings on the first and third Fridays of each month. Officers are elected for the whole year.

The purpose of the club is to stimulate an interest among its members in the whole field of engineering, and to encourage original research and observation in practical engineering problems. The programs, which are partly illustrated, consist of papers and addresses by members of the faculty and students.

## OREGON ENGINEER.

*The Oregon Engineer* is a monthly magazine published by the students of the various departments of Engineering. It has general circulation among the student body and among the engineers of the State. Its object is the dissemination of engineering news and the strengthening of the engineering work of the University. It gives all students interested an opportunity to contribute articles of interest. The control is vested in an editor-in-chief and a business manager, with their assistants.

# LABORATORY EQUIPMENT

## CIVIL ENGINEERING.

### DRAFTING ROOMS.

The drafting rooms comprise two rooms on the second floor of the new Engineering Hall, fitted up with good, substantial tables, stools, filing cases, etc.

One room, 42 x 47 feet, used for students in Drawing and Architecture, will accommodate 120 students. The other room, 22 x 30 feet, accommodates 40 students and is used for advanced classes in drafting. The blue print room adjoining the drafting room is equipped with a dark room for storing and cutting sensitized paper, with printing frames, and with a large sink and rack for washing and drying prints.

A room on the first floor is fitted up with special lockers in which is kept the surveying equipment, each locker containing a complete party outfit for plane, topographic and railroad surveying.

### TESTING LABORATORY.

The Testing Laboratory is equipped with the necessary machines and appliances for testing the strength of steel, wrought iron, cast iron, timber, stone and other materials of construction. The largest machine has a capacity of 200,000 pounds and is a universal machine, adapted to testing specimens in tension, compression, or bending; extension arms are provided to the platform, so that beams up to 16 feet in length can be tested.

The Cement Laboratory occupies a separate room and is equipped with all the apparatus required in testing cement and concrete. Regular work is done in connection with the course in Masonry, but students often undertake special work in the Cement Laboratory as a part of their theses.

### SURVEYING EQUIPMENT.

The surveying equipment includes a large assortment of transits, levels, compasses, theodolites, plane-table, sextant, barometers, precise level of the U. S. Coast and Geodetic Survey pattern, level-testing apparatus, etc., together with a full supply of tapes, chains, leveling rods, range poles, pins, and all the usual accessories. In addition to the field instruments, there are various instruments for use in plotting and mapping, such as protractors, planimeter, precision pantograph, etc.

### HYDRAULIC APPARATUS.

The equipment in Hydraulics includes field instruments for measuring the velocity and computing the volume of flowing water; lecture apparatus for demonstrating and illustrating the fundamental laws of Hydraulics, together with working models of numerous hydraulic machines, which illustrate important principles.

## ELECTRICAL ENGINEERING.

The Electrical laboratory occupies one-half of the first floor of the Electrical Building, adjoining the University power plant. Electrical power is available from three sources: (1) Three phase alternating current from city service; (2) direct current from a 25 K. W. motor generator set, and (3) direct current from two 10 K. W. compound generators driven from a Russell engine. Other sources of power supply are a 10 H. P. Nagle engine and a 5 H. P. Alamo gasoline engine.

The electrical equipment consists of at least one each of the following pieces of standard apparatus: Series, shunt, compound, and interpole direct current generators and motors; alternating current generators of single-phase, two-phase, and three-phase windings, arranged for parallel operation; alternating current motors of the induction type, with squirrel cage, internal resistance and external resistance rotors, and synchronous motors; frequency changer; synchronous converter for three-phase or six-phase operation; transformers of various sizes for one, two, three, and six phase combinations of alternating current. Auxiliaries consist of one two-panel slate switchboard with instruments, generator and feeder switches; wood skeleton switchboards for flexible wiring; lamp bank of 200 lamps arranged for 110 or 220 volt direct current, single or three-phase alternating current load; storage battery; resistances; choke coils; arc lamps, open and enclosed; circuit breakers; switches, etc. Instruments include frequency indicator; power factor indicator; synchroscope; direct current, and single and polyphase watt-hour meters; indicating watt-meters, ammeters, and voltmeters of the Weston, American and Thompson types for measurements up to 30 K. W.

In addition there are numerous pieces of apparatus to illustrate modern practice and to perform various experiments in telephone, telegraph and illuminating engineering.

The shop equipment consists of the following:

Pattern shop: Combination rip and cut-off saw, planer, band saw, jig saw, lathes, hand tools, etc.

Forge shop: Down-draft forges equipped with motor driven blower and exhauster, anvils, vises, and the usual auxiliary small tools.

Machine shop: 16 inch and 9 inch engine lathes, planer, shaper, drill presses, centering machine, power hack saw, emery wheels, and small tools for bench work.

All shops are electric motor driven.

## CHEMISTRY.

The Chemistry Department has at its disposal some ten rooms in McClure Hall, fitted up in the most modern way for the work it is to do. There are three large laboratories, equipped with tables, lockers, fume closets, ovens, furnaces, gas, water, compressed air, hydrogen sulphide mains, electrical service, balances, and in general all of the conveniences which go to facilitate chemical laboratory work.

The lecture room is supplied with the apparatus and specimen material necessary for demonstrating the latest developments in Chemistry, and constant additions are being made to the materials now on hand for this purpose.

Materials for student use in the laboratory are supplied in the greatest abundance. A well-stocked store room is accessible at all times for securing whatever may be needed in the various laboratory courses.

For the special advanced courses in Physical Chemistry, Electro Chemistry and Technical Chemistry, special apparatus is provided consisting of the most modern high and low temperature thermometers, pyrometers, calorimeters, electrical instruments, etc.

In a room adjoining the laboratories is kept on file the current issues and files of the leading chemical periodicals published in English and German, together with many treatises and reference books.

# CIVIL ENGINEERING

Professor McAlister.
Professor Frink.
Assistant Professor Adams.
Mr. McClain.

It is the aim of the Civil Engineering course to give a thorough training in the fundamental subjects which form the basis of successful and rational practice in the profession. It is recognized that theory and practice should go hand in hand, and while a mastery of theoretical principles is insisted upon, equal attention is given to the practical application of principles in the design of structures and in the execution of field and office work.

Certain fundamental subjects are required to be taken by all students in the department. In addition to these, the student must elect a considerable number of other subjects, in order to make up the total amount of work required for graduation. Thus an opportunity is afforded the student either to specialize to a certain extent along one or more chosen lines, or to take certain courses in the College of Liberal Arts, and thus broaden and strengthen his general education.

As an example of specialization, attention may be called to the course now offered in Railway Engineering, and also to the course in Hydro-Electric Engineering, given jointly by the Departments of Electrical and Civil Engineering. In a similar manner, by a proper use of electives, the student may give special attention to Structural Engineering, such as reinforced concrete, advanced bridge design, masonry arches, architecture; or to Hydraulic Engineering, such as irrigation, water supply, or sewerage and drainage; or to the various phases of Sanitary Engineering, courses of particular value in this line being given by the departments of Biology and Chemistry.

## Course in Civil Engineering.

Students taking their major in Civil Engineering will find the proper sequence of their courses outlined below:

### FRESHMAN YEAR.

| First Semester. | Hours or Periods per Week. |
|---|---|
| Mathematics 2 (Advanced Algebra, Trigonometry) | 5 |
| Chemistry 1 | 4 |
| Drawing 1 | 2 |
| Shopwork 1 (Woodworking) | 1 |
| Shopwork 5 (Machine Shop) | 1 |
| English 1, 3, 4, or 5 | 3, 2, or 1 |
| Elective (one or two hours, depending on English). | |

### Second Semester.

| | |
|---|---|
| Mathematics 2 (Analytical Geometry) | 5 |
| Chemistry 1 | 4 |
| Drawing 1 | 2 |
| Shopwork 2 (Pattern Making) | 1 |
| Shopwork 6 (Machine Shop) | 1 |
| English 1, 3, 4, or 5 | 3, 2, or 1 |
| Elective (one or two hours, depending on English). | |

## SOPHOMORE YEAR.

### First Semester.

| | |
|---|---|
| Mathematics 4 (Calculus) | 5 |
| Surveying 21 | 3 |
| Drawing 5 (Descriptive Geometry) | 2 |
| Physics 2 and 3 | 4 |
| Elective | 1 or 2 |

### Second Semester.

| | |
|---|---|
| Mathematics 4 (Calculus) | 5 |
| Surveying 21 | 3 |
| Structural Engineering 41 (Graphic Statics) | 2 |
| Physics 2 and 3 | 4 |
| Elective | 1 or 2 |

## JUNIOR YEAR.

### First Semester.

| | |
|---|---|
| Mathematics 17 (Analytical Mechanics) | 3 |
| Surveying 22 (Topographic Surveying) | 3 |
| Railway Engineering 81 (Railroad Surveying) | 5 |
| Elective | 4 or 5 |

*Industrial Electricity 12 or *Economics 3.

### Second Semester.

| | |
|---|---|
| Mathematics 17 (Analytical Mechanics) | 3 |
| Surveying 21 (Topographical Surveying) | 3 |
| Structural Engineering 42 (Strength of Materials) | 4 |
| Structural Engineering 43 (Stresses in Framed Structures) | 3 |
| Elective | 2 or 3 |

*Industrial Electricity 12 or *Economics 3.

## SENIOR YEAR.

### First Semester.

| | |
|---|---|
| Structural Engineering 44 (Masonry) | 3 |
| Structural Engineering 46 (Bridge Design) | 3 |
| Hydraulic Engineering 61 (Hydraulics) | 4 |
| Contracts and Specifications | 2 |
| Elective | 3 or 4 |

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*Courses marked thus are suggested as electives.

Second Semester.

| | |
|---|---|
| Elective | 15 |

Advanced courses in Structural Engineering, such as Reinforced Concrete, Advanced Bridge Design, Masonry Arches; or in Hydraulic Engineering, such as Irrigation, Water Supply, or Sewerage and Drainage; or in Railway Engineering; or in Architecture; or in Electrical and Mechanical Engineering; or work in any of the scientific or literary departments of the University, for which the student has the prerequisites.

## DRAWING AND ARCHITECTURE.

1. *Mechanical Drawing.* Use and care of instruments; plain lettering; elementary projections of points, lines, surfaces and solids, isometric projections; simple working drawings; shading; section lining; blue prints. Six hours in drafting room. Freshman year. Prerequisite for Engineering students.
*Two hours, both semesters.*

2. *Lettering.* Extended practice in various styles of lettering commonly used on working drawings. Three or six hours in drafting room. *One hour both semesters, or two hours one semester.*

3. *Freehand Drawing.* Application of the principles of perspective by direct observation. Pencil drawing from models and from nature. *Two hours, first semester.*

4. *History of Architecture.* A review of the conditions and motives that have given rise to the different types of architecture.
*Three hours, both semesters.*

5. *Descriptive Geometry.* Orthographic projections of points, lines, and solids; traces of lines, planes, and single-curved surfaces; cylinder, cone, and double-curved surfaces of revolution; intersection of solids by planes and development of surfaces; intersection of solids by solids; applications. Open to students who have had course 1. Prerequisite for all Engineering students. Drafting room and lectures, six hours per week.
*Two hours, first semester.*

6. *Shades and Shadows.* Practical methods of finding shadows, with special reference to architectural problems. Open to those who have had courses 1 and 5. *Two hours, second semester.*

7. *Perspective.* Analytical study of the theory and practice of perspective principles. Practical methods of application. Open to those who have had courses 1 and 5.
*Two hours, second semester.*

8. *Orders of Architecture.* A study of the character and proportions of the five orders of architecture. Open to those who have had courses 1 and 5. *Two hours, both semesters.*

9. *Machine Drawing.* Form and proportions of machine details as determined by custom and empirical formulæ, rather than by considerations of theoretical design. Open to those who have had course 1. *Two hours, both semesters.*

10. *Details of Construction.* Scale and full-size drawings showing the methods of building construction. Details of windows, doors, exterior and interior finish, etc. Open to those who have had course 1. *Three hours, first semester.*

11. *Dwelling Design.* This course is designed to follow course 10 and comprises the drawing of plans and elevations, with a study of the arrangement and architectural effects. Writing of specifications. *Two hours, second semester.*

## SURVEYING.

21. *Elementary Surveying.* Adjustment and use of instruments; land survey computations; reduction and platting of field notes; simple earthwork computations; mapping; differential and profile leveling; compass surveys; azimuth traverses; stadia measurements; simple triangulation, etc. Recitation, one hour per week; field and office work, six hours per week. Open to students who have had Freshman Mathematics and course 1. Required of all Engineering students.

*Three hours, both semesters.*

22. *Topographic Surveying.* Horizontal and vertical location of points; representation of relief by contours; determination of latitude, time, azimuth and longitude; triangulation; precise leveling; reduction formulas for surveys and map projections; adjustment of errors; details of field work; map drawing. Lectures and recitations, one hour; field work, six hours per week. Open to students who have had course 21 and Calculus. Required of students in Civil and Mining Engineering.

*Three hours, both semesters.*

23. *Astronomical Practice.* More extended practice than can be given in course 22, in determining time, latitude, longitude, and azimuth. Additional methods are also developed. Three hours field practice. Open to those who have had course 22.

*One hour, either or both semesters.*

## STRUCTURAL ENGINEERING.

41. *Graphic Statics.* Graphic methods for solving problems in the equilibrium of rigid bodies; direct applications of the general principles are made to the determination of stresses in framed structures subject to fixed loads; of shear and bending moment in beams; and of the centroid and moment of inertia of plane areas. Six hours per week in drafting room. Open to students who have had 1 and 5. Prerequisite for all Engineering students.

*Two hours, second semester.*

42. *Strength of Materials.* (a) Elements of the mathematical theory of elasticity, with applications to beams, columns, shafts, etc. Lectures and recitations, three hours per week.

(b) Testing Laboratory. Each student is required to make a series of tests of timber, wrought iron, cast iron and steel, in tension, compression, cross-bending and shear. Laboratory, three hours per week. Open to students who have had Calculus, Analytical Mechanics, and shopwork. Required of all Engineering students.
*Four hours, second semester.*

43. *Stresses in Framed Structures.* Determination by graphic and analytical methods of stresses in trusses and other framed structures, including structural details. Drafting and computations, nine hours per week. Open to students who have had Calculus and course 41, and who have had or are taking Analytical Mechanics. Required of Civil Engineering students.
*Three hours, second semester.*

44. *Masonry.* Materials, foundations, piers and abutments, retaining walls, culverts, and dams. Lectures, computations, and drafting, and laboratory work in testing stone, brick, cement, etc.; in all, nine hours per week. Open to students who have had Calculus, Analytical Mechanics, Elementary Chemistry, and courses 1, 5, and 42. Required of Civil Engineering students.
*Three hours, first semester.*

45. *Reinforced Concrete.* Theory, computation, and design of reinforced concrete beams, columns, slabs, arches, retaining walls, etc. Open to students who have had course 44.
*Three hours, second semester.*

46. *Structural Design.* Designs, drawings, bills of materials, and estimates of cost of girders and trusses of wood and steel. Drafting and computations, nine hours per week. Open to students who have had courses 42 and 43 and shopwork. Required of Civil Engineering students. *Three hours, first semester.*

47. *Advanced Bridge Design.* Courses 43 and 46 are extended to include the more complex forms of trusses, cantilever, and swing bridges for railways. Drafting and computations, lectures, and assigned readings; in all, fifteen hours per week. Open to students who have had courses 43 and 46.
*Five hours, second semester.*

48. *Masonry Arches.* Computation of stresses, designs, and drawings for arches of stone, brick or concrete. Drafting room, six hours per week. Open to students who have had courses 42 and 44. *Two hours, second semester.*

### HYDRAULIC AND MUNICIPAL ENGINEERING.

61. *Hydraulics.* Hydrostatic pressure in pipes, tanks, reservoirs, etc.; fluid motion; dynamic pressure, theoretical and empirical

formulas for flow of water through orifices, over weirs, through tubes, in pipes, conduits, canals and rivers; measurements of water power, with brief reference to common waterwheels and turbines. Open to students who have had Calculus, Analytical Mechanics, and course 21. Required of Civil Engineering students.

62. *Hydraulic Motors.* The mathematical theory and design of modern types of reaction turbines and impulse wheels, with a brief study of centrifugal pumps. Must be preceded by course 61. *Three hours, second semester.*

63. *Water Supply Systems.* Amount of water required; available sources of supply; storage reservoirs and dams; purification works; supply pipes and conduits; city mains and branches; pumping machinery, operation and maintenance. Lectures and recitations, two hours per week; drafting and computations, nine hours per week. Open to students who have had course 61. *Five hours, second semester.*

64. *Elements of Water Supply Design.* Course 63 abbreviated for students who desire a general knowledge of the subject, but do not care to make a specialty of it. Lectures, drafting and computation; in all six hours per week. Open to students who have had course 61. *Two hours, second semester.*

65. *Sewerage and Drainage Systems.* Detailed designs of systems; disposal works and drains; separate and combined systems; rainfall and run-off; estimating increase of population, sewerage per capita; ground water; grades and self cleansing velocities; use of formulas and diagrams; outfalls; disposal works. Lectures and recitations, two hours per week; computation and drafting, nine hours per week. Open to students who have had course 61. *Five hours, second semester.*

66. *Elements of Sewer Design.* Course 65 abbreviated. Lectures, drafting and computations; in all, six hours per week. Open to students who have course 61. *Two hours, second semester.*

67. *Irrigation Engineering.* Hydrography, including stream measurements; rainfall and run-off; evaporation, absorption, and seepage; duty of water; sub-surface water sources, artesian wells. Canals and canal works; surveys, alignment, slope and cross sections of canals; headworks and diversion weirs; distributary canals or ditches. Storage reservoirs, location, capacity and construction; earth, loose rock and masonry dams, waste ways and outlet sluices. Pumping water for irrigation. Recitations, three hours; field work and drafting, six hours per week. Open to students who have had courses 61, 22, 42 and 44. *Five hours, second semester.*

## CONTRACTS AND SPECIFICATIONS.

81. *Contracts and Specifications.* The law relating to contracts. Forms and details of engineering specifications.

*Two hours, second semester.*

## LABORATORY FEES.

### Second Semester.

| | | |
|---|---|---|
| 42. | Testing Laboratory | $2.50 |
| 22. | Topographic Surveying | 2.50 |
| 44. | Masonry Laboratory | 2.50 |

Key deposit for Mechanical Drawing, $1, refunded at the end of the course on the return of the key.

# ELECTRICAL ENGINEERING

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Professor Dearborn
Mr. Converse
Mr. Reid
Mr. Swift
Mr. Platts

The department of Electrical Engineering offers: (1) A four year course leading to the degree of B. S. in Electrical Engineering, as outlined. (2) A five year course in Hydro-electric Engineering, the extra year being largely devoted to consideration of hydraulics, hydro-electric plants, water storage, concrete construction, and topographic surveying. (3) A five year course leading to the degree of E. E., designed for the training of the professional electrical engineer, the additional work being partly in cultural and partly in advanced engineering work.

All of the above courses are based on the completion of four years of high school work and are planned with the object of meeting the needs of the State of Oregon and the Pacific Northwest, especial attention being given to the development of electricity from water power, with supplemental courses in steam and gas engines as prime movers.

It is the object of the department to combine a reasonable amount of specialization in the last years of the course, with a thorough grounding in the fundamentals during the earlier years. In carrying out this plan the department endeavors to make the mathematic and scientific courses strong in the earlier years and to supplement them by courses in drawing and shop practice. Theses are required of all graduates and usually take the form of investigation of engineering problems, design and construction of apparatus, power plant tests, etc.

The library is fully equipped with all the standard books on electrical engineering, bound files of the American Institute of Electrical Engineers, the Electrical World, Street Railway Journal, etc. A very liberal annual appropriation for books enables the department to obtain all the new publications immediately. About twelve electrical periodicals are regularly received. These periodicals, together with such books as are required for reference, are kept in the reading room of the electrical building for the convenience of students.

The shop courses are arranged with the object of making the student familiar with shop processes, economical production, works management, etc., at the same time cultivating a reasonable dexterity in the handling and operating of the various tools. The required shop courses include pattern making, forge work, and machine shop practice, supplemented by lectures at frequent intervals. Advanced work in the shops can be elected after the completion of the required courses.

An important feature of the work in Electrical Engineering is the inspection trip taken during the spring vacation by the advanced students of the department. The trip includes an inspection, study and report of some one of the large electrical systems of the Northwest. Students in Electrical Engineering are strongly advised to take up summer work along electrical lines, in order to gain all the practical experience possible during their University course. Such work will not only broaden their view, but will make the lecture and textbook discussions of more vital interest and value.

On completion of the four years' course at the University students are eligible to enter the apprenticeship courses of any of the large electric companies of the East. Students are employed by these companies for about two years, at the end of which time they are regularly engaged by the company or are free to take up other work, depending upon the ability and plans of the student. These apprenticeship courses are now looked upon as practical graduate courses, and the students are called from them to many important positions in either the engineering, construction or commercial phases of Electrical Engineering.

An outline of the courses in Electrical Engineering is given below to indicate a suitable sequence:

### FRESHMAN YEAR.

#### First Semester.

| | |
|---|---|
| Mathematics 2 | 5 hours |
| Physics for Engineers 2 | 3 hours |
| Physical Measurements 3 | 1 hour |
| English Composition 3 | 2 hours |
| Mechanical drawing 1 | 2 hours |
| Wood Shop 1 | 1 hour |
| Forge Work 3 | 1 hour |

#### Second Semester.

| | |
|---|---|
| Mathematics 2 | 5 hours |
| Physics for Engineers 2 | 3 hours |
| Physical Measurements 3 | 1 hour |
| English Composition 3 | 2 hours |
| Mechanical Drawing 1 | 2 hours |
| Pattern Making 2 | 1 hour |
| Forge Work 3 | 1 hour |

## SOPHOMORE YEAR.

### First Semester.

| | |
|---|---|
| Mathematics 4 | 5 hours |
| Chemistry 1 | 4 hours |
| Electrical Engineering 11 | 2 hours |
| Physics 7 | 2 hours |
| Descriptive Geometry 5 | 2 hours |
| Machine Shop 5 | 1 hour |

### Second Semester.

| | |
|---|---|
| Mathematics 4 | 5 hours |
| Chemistry 1 | 4 hours |
| Electrical Engineering 11 | 2 hours |
| Physics 13 | 2 hours |
| Graphic Statics 41 | 2 hours |
| Machine Shop 6 | 1 hour |

## JUNIOR YEAR.

### First Semester.

| | |
|---|---|
| Direct Current Machinery 13 | 4 hours |
| Steam Engines and Boilers 31 | 2 hours |
| Mathematics 17, Analytical Mechanics | 3 hours |
| Elementary Surveying 21 | 3 hours |
| Machine Drawing, C. E. 9 | 2 hours |
| Direct Current Laboratory 24 | 1 hour |
| Mechanical Laboratory 41 | 1 hour |

### Second Semester.

| | |
|---|---|
| Alternating Current Machinery 14 | 4 hours |
| Steam Engines and Boilers 31 | 2 hours |
| Mathematics 17, Analytical Mechanics | 3 hours |
| Elementary Surveying 21 | 3 hours |
| Machine Drawing, C. E. 9 | 2 hours |
| Alternating Current Laboratory 25 | 1 hour |
| Mechanical Laboratory 41 | 1 hour |

## SENIOR YEAR.

### First Semester.

| | |
|---|---|
| Alternating Current Motors 17 | 3 hours |
| Electric Power Transmission 15 | 2 hours |
| Electric Lighting 18 | 2 hours |
| Hydraulics, C. E. 61 | 4 hours |
| Internal Combustion Motors 38 | 3 hours |
| Alternating Current Laboratory 26 | 1 hour |

### Second Semester

| | |
|---|---|
| Electric Railways 16 | 2 hours |
| Telegraphy and Telephony 19 | 2 hours |
| Strength of Materials, C. E. 42 | 4 hours |
| Internal Combustion Motors 38 | 2 hours |
| Gas Engine Laboratory 42 | 1 hour |
| Thesis | 2 to 4 hours |

## COURSES IN ELECTRICAL ENGINEERING.

1. *Woodworking.* Use and care of tools. Mitering, wood-turning. Three hours a week in the shops.
*One hour, one semester.*

2. *Pattern Making.* Selection of woods. Core boxes; draft, shrinkage, etc. Three hours a week in the shops.
*One hour, one semester.*

3. *Forge Work.* Forging, welding, tool-dressing, tempering, annealing. Three hours a week in the shops.
*One hour, two semesters.*

4. *Foundry Work.* (Not given in 1910-11.) Moulding, core-making. Management of cupola and crucible furnace. Three hours a week in the shops. *One hour, two semesters.*

5. *Machine Shop.* Bench work, chipping, filing, etc. Three hours a week in the shops. *One hour, one semester.*

6. *Machine Shop.* Exercises on lathes, shaper, planer, milling machine, drill press, etc. Three hours a week in the shops.
*One hour, one semester.*

7. *Machine Shop.* Construction and erection apparatus and machines. Three hours a week in the shops. Prerequisites, courses 5 and 6. *One hour, both semesters.*

8. *Shop Lectures.* Given at various times in connection with the shop work.

10. *Electricity.* A brief general course for non-engineering students, designed to cover the simpler applications of electricity to lighting, heating, and power. Open to all students.
*One hour, one semester.*

11. *Electrical Engineering.* An introductory course for Electrical Engineers designed to lay the foundation for further analytical work. *Two hours, both semesters.*

12. *Industrial Electricity.* A general course in direct and alternating currents, with a minimum of theory, designed with especial reference to the application of electricity to industrial operations. Open to students of junior standing.
*Three hours, both semesters.*

13. *Direct Current Machinery.* Theory and design of series, shunt, and compound direct current dynamos and motors. Discussion of construction and operation of direct current machinery and its application to electric lighting and power. Prerequisites, course 4 Mathematics, and courses 2 and 3 Physics.
*Four hours, first semester.*

14. *Alternating Current Machinery.* The theory of generation of single phase and polyphase alternating currents. Graphic problems, measurement of power, theory of transformers, rotary converters, synchronous and induction motors. Prerequisite, course 13.
*Four hours, second semester.*

15. *Electric Power Transmission.* A study of the transformation, transmission, and distribution of electric energy. Prerequisites, courses 13 and 14. *Two hours, first semester.*

16. *Street Railways.* A course in street railway design, construction, operation, and economics. Prerequisite, courses 13 and 14. *Two hours, second semester.*

17. *Alternating Current Motors.* A complete discussion of the various types of alternating current motors. Prerequisite, course 14.
*Three hours, first semester.*

18. *Electric Lighting.* A study of the various electric illuminants and their adaptations to exterior and interior lighting. Open to students of junior standing. *Two hours, first semester.*

19. *Telegraphy and Telephony.* Fundamental principles of electric signalling, with illustrations of modern commercial practice. Prerequisite, courses 11, 12, or 13.
*Two hours, second semester.*

20. *Thesis.* Preliminary reading and investigation is done during first semester. Subjects must be chosen and approved before the first Monday in November. *Two hours, second semester.*

22. *Electrical Design.* Computations and design of electrical apparatus. Prerequisites, courses 13 and 14.
*One hour, second semester.*

23. *Electrical Laboratory.* Industrial. A brief course given in connection with course 12. Two hours in the laboratory.

24. *Electrical Laboratory.* Direct current. A laboratory course for the experimental study of direct current dynamos and motors; their operation, characteristic curves, and efficiencies. Taken in connection with course 13. Three hours in the laboratory.
*One hour, first semester.*

25. *Electrical Laboratory.* Alternating current. Laboratory tests of single and polyphase generators, induction and synchronous motors, transformers, frequency changers, etc. Taken in connection with course 14. Three hours in laboratory.
*One hour, second semester.*

26. *Electrical Laboratory.* Advanced laboratory work, largely on alternating current machinery. Prerequisite, courses 24 and 25. Three hours in laboratory. *One hour, first semester.*

29. *Inspection Trip.* A trip to the principal power plants and industrial centers of the Northwest, taken during Easter vacation every other year.

31. *Steam Engines and Boilers.* The theory, construction, and operation of the best types of engines and boilers. A study of valve gears, steam distribution, regulation of engines, and turbines. Fuel determination. Discussion of condensers, mechanical stokers, and chimneys. Prerequisite, course 4 in Mathematics, and courses 2 and 3 in Physics. *Two hours, both semesters.*

38. *Internal Combustion Motors.* Their theory, construction and operation will be considered in detail. Prerequisites, Mathematics 4, and Physics 2 and 3.

*Three hours, first semester.*
*Two hours, second semester.*

41. *Mechanical Laboratory.* Experiments chiefly in Steam Engineering. Engine, boiler, and pump tests. Indicators; dynamometers; fuel calorimetry; valve setting; flue gas analysis. Three hours in laboratory. Taken in connection with course 31.

*One hour, both semesters.*

42. *Gas Engine Laboratory.* Experiments on gas and gasoline engines. Taken in connection with course 38. Three hours in the laboratory. *One hour, second semester.*

## SHOP AND LABORATORY FEES.

Three dollars a semester for each course in shops and laboratories.

# CHEMICAL ENGINEERING

## GENERAL STATEMENT.

With the refined industrial development of late years and its accompanying closer competitive conditions there has arisen the necessity for a scientific control of industrial processes in order that greater economies than heretofore have been attainable may be secured. As a consequence, many industries which since time immemorial have been conducted upon a rule-of-thumb basis are requiring men with scientific training for help in their problems.

The man who can be of most help under such circumstances must be familiar not only with the scientific aspects of the work in question, but must have the ability to see the connection between the process and the material equipment necessary for carrying it on to the best advantage. In the electrical industry, for example, the man who secures results must have a happy combination of theoretical physics, upon the one hand, which will enable him to picture vividly in his mind all the various manifestations of lines of force, etc., and of mechanical constructive ability, upon the other hand, which will enable him to build a machine capable of utilizing to the utmost possible practical degree the effects which these lines of force are able to produce.

The Chemical Engineer is the outcome of the effort to combine in a single person the functions of chemist and constructing engineer, just as the Electrical Engineer is the combination of specialized physicist and constructing engineer. He should be able to devise and construct machinery for carrying out any process involving chemical action. If he has at the same time administrative ability he is the one best fitted for the superintendency of industrial plants.

The variety of such plants is large, and is continually increasing. It is impossible to enumerate all of the lines requiring chemical control, but below are representative ones, any of which will admit of almost unlimited specialization.

Acids.
Alcohol.
Alkalis.
Ammonia.
Bleaching.
Chemicals.
Clay Products.
Coal Tar and its Derivatives.
Coke.
Copper.
Electric Furnace products.

Electrometallurgy.
Explosives.
Fertilizers.
Foods.
Glass.
Glycerine.
Illuminating and Heating Gas.
Iron and Steel.
Lead.
Leather.
Lime, Cements, Plasters.
Oils, Varnishes, etc.
Paper.
Petroleum and its Derivatives.
Pigments and Paints.
Sewage Disposal.
Soap.
Soda.
Starch.
Sugar.
Water Purification.
Wood Distillation.
Zinc and other Metals.

The purpose of the course in Chemical Engineering as given at any good school is to impart the necessary academic training which shall then serve as the basis of future practical work. More or less apparatus is at hand, to be sure, which is the same as that used in practical work, and the endeavor is to increase its amount. In the four years available for school work, however, there is scarcely time for the absolutely essential class-room work, so that time for practice upon a technical scale to any very great extent is out of the question, however good the equipment for such work may be. It is the concensus of opinion among men highest in the industrial affairs of this country that the four years in school should be given over almost exclusively to the academic side of the training of the Engineer, and that his real practical training should be secured in the industrial plant itself.

The equipment of the Chemical Laboratories for the regular work in Chemistry is unusually fine. Three well-ventilated and well lighted laboratories are available for student use, besides a commodious lecture room, weighing rooms, store room, etc. All apparatus is chosen with a view to the exemplification of the very latest developments in the subject, and the amount supplied to each student is limited only by his own desires in the matter. Numerous laboratory conveniences, such as gas, water, steam, compressed air, vacuum, furnaces, balances, electricity, hydrogen sulphide mains, electrically exhausted fume closets, etc., are at the disposal of everyone.

In the fourth year of the Chemical Engineering course special courses in Chemistry are offered bearing more directly upon industrial problems. Much of the equipment for these courses is identical with that used upon a technical scale, including bomb calorimeters, apparatus for electrochemical measurements and technical processes, the refining of chemicals, etc.

The equipment in the purely Engineering subjects is described elsewhere. It includes testing laboratories, shops, drafting rooms, and so on, all well supplied with apparatus, which in many instances is to be equaled only in a few of the very largest schools of the country.

## THE COURSE OF STUDY.

The subjects pursued in the course in Chemical Engineering are grouped around the two main lines which the course contemplates, —Chemistry and Engineering.

In Chemistry the work starts with a thorough general survey of the subject as given in Course 1; continues with a year of analytical work, qualitative and quantitative; and then in succession follow Organic Chemistry, Physical Chemistry, Advanced Analysis, Electro Chemistry and finally the technical courses.

The beginning of the Engineering work is made in drafting and shop work, which are followed as soon as sufficient mathematical training has been acquired, by the higher technical courses.

As preparatory for, or adjunctive to these main lines of study are Mathematics and Physics, and at the same time there is a useful variation from the purely engineering or chemical work in a course or two in Languages and Economics.

Two years of a foreign language, German or French preferred, must be offered to fulfil the language entrance requirement for the course in Chemical Engineering.

The following is the course of study for Chemical Engineering:

### FRESHMAN YEAR:

| First Semester | | Second Semester | |
|---|---|---|---|
| Mathematics 2 | 5 hours | Mathematics 2 | 5 hours |
| Chemistry 1 | 4 hours | Chemistry 1 | 4 hours |
| German 10 | 2 hours | English Composition 1 | 3 hours |
| or | | Physics 2 | 3 hours |
| French 5 | 2 hours | Physics 3 | 1 hour |
| Physics 2 | 3 hours | | |
| Physics 1 | 1 hour | | |

### SOPHOMORE YEAR:

| First Semester | | Second Semester | |
|---|---|---|---|
| Drawing 1 | 2 hours | Drawing 1 | 2 hours |
| Chemistry 3 | 4 hours | Chemistry 3 | 4 hours |
| Mathematics 4 | 5 hours | Mathematics 4 | 5 hours |
| Shop 1 | 1 hour | Shop 1 | 1 hour |
| Economics 6 | 3 hours | To be arranged | 3 or 4 hours |

### JUNIOR YEAR:

| First Semester | | Second Semester | |
|---|---|---|---|
| Organic Chemistry 5 | 4 hours | Organic Chemistry 5 | 4 hours |
| Physical Chemistry 6 | 4 hours | Inorganic Chemistry 12 | 4 hours |
| Analytical Mechanics 7 | 3 hours | Analytical Mechanics 17 | 3 hours |
| Descriptive Geometry 5 | 2 hours | Graphic Statics 41 | 2 hours |
| Shop 5 | 1 hour | Shop 5 | 1 hour |
| Electrical Engineering 11 | 2 hours | Electrical Engineering 11 | 2 hours |

### SENIOR YEAR:

| First Semester | | Second Semester | |
|---|---|---|---|
| Analytical Chemistry 12 | 3 hours | Industrial Chemistry 14 | 3 hours |
| Industrial Chemistry 14 | 3 hours | Electro Chemistry 18 | 2 hours |
| Metallurgy | 3 hours | Business Law | 2 hours |
| Chemical Engineering 20 | 2 hours | Machine Drawing 9 | 2 hours |
| Machine Drawing 9 | 2 hours | Strength of Materials 42 | 4 hours |
| Sanitary Chemistry 22 | 2 hours | Thesis | |
| Thesis | | | |

# RAILWAY ENGINEERING

Professor Frink.

The offer of a major course in Railway Engineering follows naturally the increasing importance of Oregon as a railway state, with the consequent demand for trained engineers in the planning, execution and operation of projects of this nature.

The four years course outlined below is based upon the fundamental features of Civil Engineering, with especial attention to the design of bridges and other engineering structures, followed during the last two years of the course by study of more strictly railway interest.

Class-room instruction is given by text and reference books, published reports and by lectures. The solution of numerical problems arising in practice is a prominent feature. Field practice includes the steps of projecting a short railway line, from reconnaissance to staking out for construction. Modern methods regarding notes, maps and profiles are observed.

While providing such instruction as will fit the student for immediate usefulness in the field or drafting room, the importance of preparing for positions of greater responsibility is recognized. To that end a study is made of railway economics and applications made especially to problems of location.

The course also includes a study of the laws relating to contracts and other business operations occurring in engineering practice.

Examination of engineering features of the locality are made during the year, and during the course at least one extended trip of inspection, extending over about one week, will be made. It is strongly urged that summer vacations be devoted to acquiring experience in some branch of railway engineering.

The courses given below are offered in Railway Engineering. Students making the subject their major should observe the following sequence in arrangement of work:

## Course in Railway Engineering.

### FRESHMAN YEAR.

### First Semester.

| | |
|---|---|
| Mathematics 2 | 5 hours |
| Mechanical Drawing 1 | 2 hours |
| Chemistry 1 | 4 hours |
| Wood Shop 1 | 1 hour |
| Forge Work 3 | 1 hour |
| Machine Shop 5 | 1 hour |
| English 3 | 2 hours |
| Total | 16 hours |

### Second Semester.

| | |
|---|---|
| Mathematics 2 | 5 hours |
| Mechanical Drawing 1 | 2 hours |
| Chemistry 1 | 4 hours |
| Pattern Making 2 | 1 hour |
| Forge Work 3 | 1 hour |
| Machine Shop 6 | 1 hour |
| English 3 | 2 hours |
| Total | 16 hours |

## SOPHOMORE YEAR.

### First Semester.

| | |
|---|---|
| Mathematics 4 | 5 hours |
| Descriptive Geometry 5 | 2 hours |
| Elementary Surveying 21 | 3 hours |
| Steam Engines 31 | 2 hours |
| Physics | 4 hours |
| Total | 16 hours |

### Second Semester.

| | |
|---|---|
| Mathematics 4 | 5 hours |
| Graphic Statics 41 | 2 hours |
| Elementary Surveying 21 | 3 hours |
| Steam Engines 31 | 2 hours |
| Physics | 4 hours |
| Total | 16 hours |

## JUNIOR YEAR.

### First Semester.

| | |
|---|---|
| Mathematics 17 | 3 hours |
| Railway Location 4 | 5 hours |
| Topographic Surveying 22 | 3 hours |
| Economics 6 | 3 hours |
| Elective | 2 hours |
| Total | 16 hours |

### Second Semester.

| | |
|---|---|
| Mathematics 17 | 3 hours |
| Strength of Materials 42 | 4 hours |
| Topographic Surveying 22 | 3 hours |
| Stresses 43 | 3 hours |
| Economics 23 | 1 hour |
| Maintenance of Way 2 | 2 hours |
| Total | 16 hours |

### SENIOR YEAR.

#### First Semester.

| | |
|---|---|
| Structural Design 46 | 3 hours |
| Masonry 44 | 3 hours |
| Hydraulics 61 | 4 hours |
| Railway Operation 3 | 4 hours |
| Elective | 2 hours |
| Total | 16 hours |

#### Second Semester.

| | |
|---|---|
| Reinforced Concrete 45 | 3 hours |
| Roads and Pavements 6 | 2 hours |
| Economic Location 4 | 2 hours |
| Railway Design 5 | 3 hours |
| Engineering Contracts 7 | 2 hours |
| Elective | 4 hours |
| Total | 16 hours |

1. *Railroad Surveying.* Reconnaissance, preliminary survey, location survey; simple curves; compound curves; transition curves; vertical curves; earthwork; switches and crossings. Recitations, two hours; field and office work, nine hours per week. Open to students who have had course 21. Required of Civil Engineering students. *Five hours, first semester.*

2. *Maintenance of Way.* Construction and maintenance of track details and minor structures. Organization and methods. *Two hours, second semester.*

3. *Railway Operation.* Yards and terminals, signals, working and wrecking trains. Relation between operating and engineering departments. *Four hours, first semester.*

4. *Economic Railway Location.* A study of the sources of income; operating expenses; distance, grades and curvature as affecting first cost; maintenance and operation; relative power of locomotives; rolling stock, train resistance, etc. Assigned readings, reports and recitations. Open to seniors or graduates who have had course 1. *Two hours, second semester.*

5. *Railway Design.* Examination and criticism of existing railways. Inspection trip during Easter vacation. This course is preceded or accompanied by course 4, and is taken in the senior year. *Three hours, second semester.*

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